

Patent Claims:

1. Electrohydraulic brake system for motor vehicles which can be operated in a 'brake-by-wire' mode of operation both by the operator and independently of the operator, comprising:

- a master cylinder (1) to which wheel brake cylinders can be connected,
- a first piston (2) which is coupled to a brake pedal (3),
- a second piston (4) which actuates the master cylinder (1),
- a third piston (5) which can be operated by the first piston (2),

with at least one brake pedal characteristics simulation device (6, 7) being provided between the first (2) and the third piston (5) and imparting a comfortable pedal feel to the operator in a 'brake-by-wire' mode of operation, with a hydraulic chamber (21) cooperating with the brake pedal characteristics simulation device (6, 7) being limited between the first (2) and the third piston (5), and all three pistons (2, 4, 5) and the brake pedal characteristics simulation device (6, 7) are arranged in a housing (8),

- a hydraulic pressure source (9) which can be operated by means of an electronic control and regulation unit, and
- a valve device (10) operable by the third piston (5) for reducing the pressure of the pressure source (9) to a value used for application of the second piston (4),

and the second (4) and the third piston (5) are isolated from each other by a space (11) in such a fashion that the third piston (5) is acted upon by the pressure that acts on the second piston (4) in the direction opposite to the direction of application of the second piston (4),  
c h a r a c t e r i z e d in that there is provision of a device (29 - 31, 45) which, by way of a variation of the pressure fluid volume in the hydraulic chamber (21) controlled by electromagnetic valve, allows a pedal performance that differs from the brake pedal characteristics that is predefined by the brake pedal characteristics simulation device.

2. Brake system as claimed in claim 1,  
c h a r a c t e r i z e d in that the device (29 - 31) is electrically controllable by the electric control and regulation unit.
3. Brake system as claimed in claim 2,  
c h a r a c t e r i z e d in that the electrically controllable device is formed of an electromagnetically operable two-way/two-position directional control valve

(29) inserted into a first connection (40) between the hydraulic chamber (21) and an unpressurized pressure fluid supply reservoir (22), a second electromagnetically operable two-way/two-position directional control valve (30) inserted into a second connection (42) between the hydraulic chamber (21) and the unpressurized pressure fluid supply reservoir (22), as well as a third electromagnetically operable two-way/two-position directional control valve (31) inserted into a conduit (43) leading to the pressure source (9 or 19).

4. Brake system as claimed in claim 2 or 3,  
c h a r a c t e r i z e d in that a pressure sensor (32) is provided to determine the pressure prevailing in the hydraulic chamber (21).
5. Brake system as claimed in any one of claims 2 to 4,  
c h a r a c t e r i z e d in that the first two-way/two-position directional control valve (29) is configured as a normally open (NO) valve, while the second two-way/two-position directional control valve (30) is configured as a normally closed (NC) valve.
6. Brake system as claimed in any one of claims 2 to 5,  
c h a r a c t e r i z e d in that the third two-way/two-position directional control valve (31) is configured as a normally closed (NC) valve which closes the hydraulic conduit (43) in its first switch position and fulfils the function of a non-return valve closing towards the pressure source (9, or 19) in its second switch position.

7. Brake system as claimed in any one of claims 1 to 6,  
c h a r a c t e r i z e d in that a sensor (39) is  
provided to monitor the charging condition of the high-  
pressure accumulator (19), whose output signal is sent to  
the electronic control unit and which is integrated in the  
housing (8) or form-lockingly connected to it.
8. Brake system as claimed in any one of claims 1 to 7,  
c h a r a c t e r i z e d in that a pressure sensor  
(18) is provided to sense the pressure that prevails in  
the space (11), whose output signal is sent to the  
electronic control unit and which is integrated in the  
housing (8) or form-lockingly connected to it.
9. Brake system as claimed in any one of the preceding  
claims,  
c h a r a c t e r i z e d in that an electrohydraulic  
control or regulation unit (28) of an anti-lock system  
(ABS) is connected to the master brake cylinder (1).
10. Brake system as claimed in any one of the preceding  
claims,  
c h a r a c t e r i z e d in that the brake pedal  
characteristics simulation device comprises at least  
one elastic element (6, 7) which exerts a 'spring  
force' component of the force generated by the brake  
pedal characteristics simulation device which depends  
on the relative travel between first (2) and third  
piston (5).

11. Brake system as claimed in claim 12\*,  
c h a r a c t e r i z e d in that the brake pedal characteristics simulation device comprises at least one damping device which exerts a 'damping force' component of the force generated by the brake pedal characteristics simulation device that depends on the relative speed between the first (2) and the third piston (5).
12. Brake system as claimed in claim 12 or 13\*\*,  
c h a r a c t e r i z e d in that the brake pedal characteristics simulation device (6, 7) comprises at least one of the components 'steel spring, elastomeric body, and frictional connection' exerting the force generated by the brake pedal characteristics simulation device.
13. Brake system as claimed in claim 14\*\*\*,  
c h a r a c t e r i z e d in that each of the components exerting the force generated by the brake pedal characteristics simulation device are arranged either outside ('dry') or inside ('wet') the hydraulic chamber (21).
14. Brake system as claimed in any one of the preceding claims 1 to 13,  
c h a r a c t e r i z e d in that the pedal performance differing from the predetermined brake pedal characteristics includes electronically controlled pedal vibrations.

15. Brake system as claimed in any one of the preceding claims 1 to 13,  
c h a r a c t e r i z e d in that the pedal performance differing from the predetermined brake pedal characteristics includes an electronically controlled temporary push back of the brake pedal.